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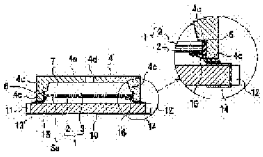
(54) **PIEZOELECTRIC ACOUSTIC COMPONENT AND ITS MANUFACTURING METHOD**



(57)Abstract:

PROBLEM TO BE SOLVED: To obtain a piezoelectric acoustic component with a high production efficiency, an excellent acoustic transudation efficiency, configured to be small in size and having an excellent shock-resistance.

SOLUTION: A uni-morph diaphragm 1 is configured by adhering a rectangular piezoelectric element 2 to a rectangular metallic plate 3, both ends of the digital signal 1 in the length direction are supported by a support section 4c formed to the inside of two opposed side walls 4b of a case 4 and a gap between the remaining two sides of the diaphragm 1 and the case 4 is sealed by an elastic seal member 6. The case 4 is adhered to a base 10 having external electrodes 13, 14, the metallic plate 3 is connected to the external electrode 13 with conductive paste 15 with elasticity and a surface electrode 2a of the piezoelectric element 2 is connected to the external electrode 14 with conductive paste 16 with elasticity. Thus, the connection reliability between the diaphragm 1 and the external terminals 13, 14 or the base 10 can be enhanced against shock.

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CLAIMS

[Claim(s)]

[Claim 1] The piezo-electric diaphragm of the square which the 1st and 2nd diaphragm electrode is exposed to the one side side of both ends, and vibrates in die-length bending mode, The insulating case which has the upper wall section and the four side-attachment-wall sections, and has a supporter inside the two side-attachment-wall sections which counter, Have the 1st and the plate-like substrate with which the 2nd external electrode was formed, and the above-mentioned diaphragm is contained so that the field which the 1st and 2nd diaphragm electrode exposes in a case may turn to the upper wall section and the opposite side of a case. Two sides which a diaphragm counters are supported with supporting material to the above-mentioned supporter, and the

closure of the clearance between remaining two sides and cases of a diaphragm is carried out with an elastic sealing agent. While sound space is formed between a diaphragm and the upper wall section of a case and the side-attachment-wall section opening edge of the above-mentioned case pastes up on the above-mentioned substrate They are the piezo-electric sound components characterized by for the 1st diaphragm electrode of the above-mentioned diaphragm being electrically connected with the 1st external electrode by electroconductive glue with elasticity, and the diaphragm electrode of the above 2nd being electrically connected with the 2nd external electrode by electroconductive glue with elasticity.

[Claim 2] The piezo-electric diaphragm of the square which the 1st and 2nd diaphragm electrode is exposed to the one side side of both ends, and vibrates in area crookedness mode, The insulating case which has the upper wall section and the four side-attachment-wall sections, and has a supporter inside the four side-attachment-wall sections, Have the 1st and the plate-like substrate with which the 2nd external electrode was formed, and the above-mentioned diaphragm is contained so that the field which the 1st and 2nd diaphragm electrode exposes in a case may turn to the upper wall section and the opposite side of a case. While four sides of a diaphragm are supported with supporting material to the above-mentioned supporter, sound space is formed between a diaphragm and the upper wall section of a case and the side-attachment-wall section opening edge of the above-mentioned case pastes up on the above-mentioned substrate They are the piezo-electric sound components characterized by for the 1st diaphragm electrode of the above-mentioned diaphragm being electrically connected with the 1st external electrode by electroconductive glue with elasticity, and the diaphragm electrode of the above 2nd being electrically connected with the 2nd external electrode by electroconductive glue with elasticity.

[Claim 3] And it is the uni-morph mold piezo-electricity diaphragm which while is supported by the supporter of a case and the piezoelectric device pasted up on

the location which inclined at the side side. the above-mentioned diaphragm -- one side of a metal plate -- While the electrode of one side of a piezoelectric device exposed outside constitutes the 1st diaphragm electrode It is the piezo-electric sound component according to claim 1 or 2 characterized by preparing the outcrop of a metal plate in the other side side of the field which the piezoelectric device of the above-mentioned diaphragm pasted up, for this outcrop constituting the 2nd diaphragm electrode, and for the above-mentioned diaphragm turning that metal plate to the upper wall section side of a case, and being attached in a case.

[Claim 4] For the electroconductive glue with the above-mentioned elasticity, the Young's modulus after hardening is 1x105 - 2x109 N/m2. Piezo-electric sound component according to claim 1 to 3 characterized by being electroconductive glue.

[Claim 5] The supporting material which supports two sides which the above-mentioned diaphragm counters to the above-mentioned supporter is piezo-electric sound components given in either of claims 1, 3, and 4 characterized by consisting of same ingredients as an elastic sealing agent.

[Claim 6] The process for which the piezo-electric diaphragm of the square which the 1st and 2nd diaphragm electrode is exposed to the one side side of both ends, and vibrates in die-length bending mode is prepared, The process for which the insulating case which has the upper wall section and the four side-attachment-wall sections, and has a supporter inside the two side-attachment-wall sections which counter is prepared, The 1st and the process for which the plate-like substrate with which the 2nd external electrode was formed is prepared, While supporting two sides which it contains so that the field where the 1st and 2nd diaphragm electrode exposes the above-mentioned diaphragm in a case may turn to the upper wall section and the opposite side of a case, and a diaphragm counters with supporting material to the above-mentioned supporter The process which closes the clearance between remaining two sides and cases of a diaphragm with an elastic sealing agent, and forms sound space between a

diaphragm and the upper wall section of a case, The process which applies continuously the electroconductive glue which has elasticity from the 1st diaphragm electrode of the above-mentioned diaphragm to the side-attachment-wall section opening edge of a case, The process which applies continuously the electroconductive glue which has elasticity from the 2nd diaphragm electrode of the above-mentioned diaphragm to the side-attachment-wall section opening edge of a case, The process which applies insulating adhesives to the above-mentioned substrate top face or the side-attachment-wall section opening edge of the above-mentioned case, The process which connects the 1st diaphragm electrode, the 1st external electrode and the 2nd diaphragm electrode, and the 2nd external electrode mutually with electroconductive glue at the same time it pastes up the side-attachment-wall section opening edge of a case with insulating adhesives on the above-mentioned substrate, The manufacture approach of piezo-electric sound components equipped with the process which makes coincidence harden the above-mentioned insulating adhesives and electroconductive glue.

[Claim 7] The process for which the piezo-electric diaphragm of the square which the 1st and 2nd diaphragm electrode is exposed to the one side side of both ends, and vibrates in area crookedness mode is prepared, The process for which the insulating case which has the upper wall section and the four side-attachment-wall sections, and has a supporter inside the four side-attachment-wall sections is prepared, The 1st and the process for which the plate-like substrate with which the 2nd external electrode was formed is prepared, It contains so that the field where the 1st and 2nd diaphragm electrode exposes the above-mentioned diaphragm in a case may turn to the upper wall section and the opposite side of a case. The process which supports four sides of a diaphragm with supporting material to the above-mentioned supporter, and forms sound space between a diaphragm and the upper wall section of a case, The process which applies continuously the electroconductive glue which has elasticity from the 1st diaphragm electrode of the above-mentioned diaphragm to

the side-attachment-wall section opening edge of a case, The process which applies continuously the electroconductive glue which has elasticity from the 2nd diaphragm electrode of the above-mentioned diaphragm to the side-attachment-wall section opening edge of a case, The process which applies insulating adhesives to the above-mentioned substrate top face or the side-attachment-wall section opening edge of the above-mentioned case, The process which connects the 1st diaphragm electrode, the 1st external electrode and the 2nd diaphragm electrode, and the 2nd external electrode mutually with electroconductive glue at the same time it pastes up the side-attachment-wall section opening edge of a case with insulating adhesives on the above-mentioned substrate, The manufacture approach of piezo-electric sound components equipped with the process which makes coincidence harden the above-mentioned insulating adhesives and electroconductive glue.

[Translation done.]

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2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to a piezo-electric sound component

and its manufacture approaches, such as a piezo-electric buzzer and a piezo-electric earphone.

[0002]

[Description of the Prior Art] Conventionally, in electronic equipment, home electronics, a portable telephone, etc., piezo-electric sound components are widely used as the piezo-electric buzzer which generates an alarm tone and a sound of operation, or a piezo-electric earphone. Its thing of the structure which closed opening of a case with covering (not shown) is common while this kind of piezo-electric sound components stick a circular piezoelectric device on one side of a circular metal plate, constitute a uni-morph mold diaphragm, and silicone rubber is used for them and they support the periphery section of a metal plate in a circular case. However, when the circular diaphragm was used, there was a trouble that productive efficiency was bad and it was difficult for sound conversion efficiency to constitute low and small.

[0003] Then, these people are using a square diaphragm and proposed the piezo-electric sound components which enabled improvement in productive efficiency, the improvement in sound conversion efficiency, and a miniaturization (Japanese Patent Application No. No. 293204 [11 to]). The diaphragm with which this piezo-electric sound component stuck the square piezoelectric device on one side of a square metal plate, The insulating case which has the upper wall section and the four side-attachment-wall sections, and has a supporter inside the two side-attachment-wall sections which counter, It has the 1st and the plate-like substrate with which the 2nd external electrode was formed. In a case, a diaphragm is contained, two sides and supporter with which a diaphragm counters are fixed with supporting material, the closure of the clearance between remaining two sides and cases of a diaphragm is carried out with an elastic sealing agent, and sound space is formed between a diaphragm and the upper wall section of a case. And while the side-attachment-wall section opening edge of a case pastes up on a substrate, a metal plate is electrically connected to the 1st external electrode, and the electrode of a piezoelectric device is electrically

connected to the 2nd external electrode.

[0004]

[Problem(s) to be Solved by the Invention] Although the surface mount by reflow soldering has become common and the subassembly by the machine is in use in current and electronic parts, to also constitute piezo-electric sound components in a surface mount mold is desired. For that purpose, it is desirable to connect the external electrode of a diaphragm and a substrate electrically using electroconductive glue. However, when the electroconductive glue of the epoxy system currently generally used was used, there was a case where a sound pressure property and engine performance sufficient in respect of shock resistance were not obtained. That is, if in the case of pocket devices, such as a portable telephone, it may be made to fall accidentally, a big impact load may be added and epoxy system electroconductive glue is used, according to an impact load, a crack will enter and between the external electrodes of a diaphragm and a substrate will be disconnected.

[0005] Then, it is to obtain the piezo-electric sound components excellent also in shock resistance while the purpose of this invention has high productive efficiency, and its sound conversion efficiency is good and can constitute it small.

[0006]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, invention according to claim 1 The piezo-electric diaphragm of the square which the 1st and 2nd diaphragm electrode is exposed to the one side side of both ends, and vibrates in die-length bending mode, The insulating case which has the upper wall section and the four side-attachment-wall sections, and has a supporter inside the two side-attachment-wall sections which counter, Have the 1st and the plate-like substrate with which the 2nd external electrode was formed, and the above-mentioned diaphragm is contained so that the field which the 1st and 2nd diaphragm electrode exposes in a case may turn to the upper wall section and the opposite side of a case. Two sides which a diaphragm counters are supported with supporting material to the above-mentioned supporter, and

the closure of the clearance between remaining two sides and cases of a diaphragm is carried out with an elastic sealing agent. While sound space is formed between a diaphragm and the upper wall section of a case and the side-attachment-wall section opening edge of the above-mentioned case pastes up on the above-mentioned substrate The piezo-electric sound components characterized by for the 1st diaphragm electrode of the above-mentioned diaphragm being electrically connected with the 1st external electrode by electroconductive glue with elasticity, and the diaphragm electrode of the above 2nd being electrically connected with the 2nd external electrode by electroconductive glue with elasticity are offered. Moreover, the piezo-electric diaphragm of the square which the 1st and 2nd diaphragm electrode exposes invention according to claim 2 to the one side side of both ends, and vibrates in area crookedness mode, The insulating case which has the upper wall section and the four side-attachment-wall sections, and has a supporter inside the four side-attachment-wall sections, Have the 1st and the plate-like substrate with which the 2nd external electrode was formed, and the above-mentioned diaphragm is contained so that the field which the 1st and 2nd diaphragm electrode exposes in a case may turn to the upper wall section and the opposite side of a case. While four sides of a diaphragm are supported with supporting material to the above-mentioned supporter, sound space is formed between a diaphragm and the upper wall section of a case and the side-attachment-wall section opening edge of the above-mentioned case pastes up on the above-mentioned substrate The piezo-electric sound components characterized by for the 1st diaphragm electrode of the above-mentioned diaphragm being electrically connected with the 1st external electrode by electroconductive glue with elasticity, and the diaphragm electrode of the above 2nd being electrically connected with the 2nd external electrode by electroconductive glue with elasticity are offered. Moreover, the process for which the piezo-electric diaphragm of the square which the 1st and 2nd diaphragm electrode exposes invention according to claim 6 to the one side side of both ends, and vibrates in die-length bending mode is

prepared, The process for which the insulating case which has the upper wall section and the four side-attachment-wall sections, and has a supporter inside the two side-attachment-wall sections which counter is prepared, The 1st and the process for which the plate-like substrate with which the 2nd external electrode was formed is prepared, While supporting two sides which it contains so that the field where the 1st and 2nd diaphragm electrode exposes the above-mentioned diaphragm in a case may turn to the upper wall section and the opposite side of a case, and a diaphragm counters with supporting material to the above-mentioned supporter The process which closes the clearance between remaining two sides and cases of a diaphragm with an elastic sealing agent, and forms sound space between a diaphragm and the upper wall section of a case, The process which applies continuously the electroconductive glue which has elasticity from the 1st diaphragm electrode of the above-mentioned diaphragm to the side-attachment-wall section opening edge of a case, The process which applies continuously the electroconductive glue which has elasticity from the 2nd diaphragm electrode of the above-mentioned diaphragm to the side-attachment-wall section opening edge of a case, The process which applies insulating adhesives to the above-mentioned substrate top face or the side-attachment-wall section opening edge of the above-mentioned case, The process which connects the 1st diaphragm electrode, the 1st external electrode and the 2nd diaphragm electrode, and the 2nd external electrode mutually with electroconductive glue at the same time it pastes up the side-attachment-wall section opening edge of a case with insulating adhesives on the above-mentioned substrate, The manufacture approach of piezo-electric sound components equipped with the process which makes coincidence harden the above-mentioned insulating adhesives and electroconductive glue is offered. Furthermore, the process for which the piezo-electric diaphragm of the square which the 1st and 2nd diaphragm electrode exposes invention according to claim 7 to the one side side of both ends, and vibrates in area crookedness mode is prepared, The process for which the insulating case which has the upper wall section and the four side-attachment-

wall sections, and has a supporter inside the four side-attachment-wall sections is prepared, The 1st and the process for which the plate-like substrate with which the 2nd external electrode was formed is prepared, It contains so that the field where the 1st and 2nd diaphragm electrode exposes the above-mentioned diaphragm in a case may turn to the upper wall section and the opposite side of a case. The process which supports four sides of a diaphragm with supporting material to the above-mentioned supporter, and forms sound space between a diaphragm and the upper wall section of a case, The process which applies continuously the electroconductive glue which has elasticity from the 1st diaphragm electrode of the above-mentioned diaphragm to the side-attachment-wall section opening edge of a case, The process which applies continuously the electroconductive glue which has elasticity from the 2nd diaphragm electrode of the above-mentioned diaphragm to the side-attachment-wall section opening edge of a case, The process which applies insulating adhesives to the above-mentioned substrate top face or the side-attachment-wall section opening edge of the above-mentioned case, The process which connects the 1st diaphragm electrode, the 1st external electrode and the 2nd diaphragm electrode, and the 2nd external electrode mutually with electroconductive glue at the same time it pastes up the side-attachment-wall section opening edge of a case with insulating adhesives on the above-mentioned substrate, The manufacture approach of piezo-electric sound components equipped with the process which makes coincidence harden the above-mentioned insulating adhesives and electroconductive glue is offered.

[0007] Since the piezoelectric device which constitutes a diaphragm is a square, even if it pierces a piezoelectric device from a green sheet, it is extracted, and can lessen dregs and its ingredient effectiveness is good. Moreover, since the activity of electrode formation, polarization, etc. can be performed in the state of a parent substrate, productive efficiency is good. Furthermore, in order to decide a dimension required in design with a parent substrate cut dimension, it does not need to create the punching metal mold of a green sheet like a disc-like

piezoelectric device each time. That is, since the metal mold in punching of a green sheet - a parent substrate cut process, a fixture, a piezo electric crystal form, etc. can be lessened compared with the former, it is advantageous in respect of an investment frame and productive efficiency.

[0008] Invention concerning claim 1 is an example suitable for the application as an earphone, and since it corresponds to the frequency of a large range, not only a resonance field but fields other than a resonance field are used. Two sides which a square-like diaphragm counters are supported with supporting material to the supporter of a case, and the clearance between remaining two sides and cases is closed with the elastic sealing agent so that it can displace, even if the vibrational energy of a diaphragm is comparatively small. A piezoelectric device will expand and contract in the predetermined direction, and if predetermined signalling frequency is inputted into two diaphragm inter-electrode of a diaphragm, according to this, a diaphragm will be deformed by flexion in die-length bending mode. at this time, a diaphragm vibrates up and down as a knot, and shows the both ends fixed to the case to (b) of drawing 1 -- as -- max -- a variation rate -- Point P exists along with the center line of the die-length direction of a diaphragm. In addition, by drawing 1 , in order to simplify explanation, the example of a uni-morph form diaphragm is shown. on the other hand -- the case of a disc-like diaphragm -- (a) of drawing 1 -- like -- a core -- max -- a variation rate -- Point P exists. That is, in the case of a square-like diaphragm, the displacement volume becomes large compared with the conventional disc-like diaphragm. Since this displacement volume serves as energy to which air is moved, it can raise sound conversion efficiency. In addition, although the clearance between the crosswise both ends of a diaphragm and a case is closed with the sealing agent, since a sealing agent has elasticity, the variation rate of a diaphragm is not barred and sound pressure does not fall. Furthermore, although, as for a diaphragm, the die-length direction both ends are fixed, since a part in the meantime can be displaced freely, the sound of a low frequency can be obtained compared with a disc-like diaphragm. On the contrary, a dimension can

be miniaturized if the sound of the same frequency is obtained.

[0009] On the other hand, invention concerning claim 2 is an example suitable for applications, such as a sounder and a ringer, and since it corresponds to the amount of Oto in single frequency, it is used in a resonance field. In order enlarge vibrational energy of a diaphragm and to make it excite in area crookedness mode, it has structure which supported all four sides of a square-like diaphragm with supporting material to the supporter of a case. in addition, two diagonal line locations which area crookedness mode is a square with which a diaphragm contains a rectangle, and make the principal plane of a diaphragm -- max -- it becomes a variation rate -- as -- that is, the intersection of the diagonal line -- max -- a variation rate -- the whole area of a diaphragm carries out crookedness vibration in the thickness direction so that it may become an amount.

[0010] In this invention, like elastic sealing agents, such as silicone rubber, as a supporting material, the Young's modulus in a hardening condition may be high like epoxy system adhesives, the edge of a diaphragm may be restrained strongly, and the Young's modulus in a hardening condition is low, and the restraint of a diaphragm is weak and may permit the variation rate of a diaphragm.

[0011] Drawing 2 is the comparison Fig. showing the relation between the dimension of a circular diaphragm and a square diaphragm, and resonance frequency. The uni-morph mold diaphragm was used also in this case. In addition, in the comparison, 42nickel whose thickness is 50 micrometers as a metal plate was used using PZT whose thickness is 50 micrometers as a piezoelectric device. Moreover, die-length L of a square diaphragm and the ratio of width of face W were set to 1.67. If it is the same frequency so that clearly from drawing, a square diaphragm can make a dimension (die length, diameter) small compared with a circular diaphragm. On the contrary, a low frequency can be obtained if the dimension is the same.

[0012] In this invention, adhesion immobilization of the case which fixed the

diaphragm is carried out at a plate-like substrate. And the electroconductive glue in which the 1st diaphragm electrode has elasticity to the 1st external electrode of a substrate connects electrically, the electroconductive glue in which the 2nd diaphragm electrode has elasticity to the 2nd external electrode of a substrate connects electrically, and piezo-electric sound components are obtained. In addition, it can constitute in a surface mount mold by taking about the 1st and 2nd external electrode prepared in the substrate to the rear face of a substrate. Since electroconductive glue has elasticity, even if it drops the device carrying these piezo-electric sound components accidentally and a big impact load is added, a crack does not enter but there is no possibility that between a diaphragm electrode and external electrodes may be disconnected. Moreover, since the Young's modulus after hardening of electroconductive glue is low, vibration of a diaphragm is not controlled and sound pressure does not fall.

[0013] And while is supported by the supporter of a case and the uni-morph mold piezo-electricity diaphragm which the piezoelectric device pasted up is used for the location which inclined at the side side. claim 3 -- like -- as a diaphragm -- one side of a metal plate -- While the electrode of one side of a piezoelectric device exposed outside constitutes the 1st diaphragm electrode It is desirable to prepare the outcrop of a metal plate in the other side side of the field which the piezoelectric device of a diaphragm pasted up, and to constitute the 2nd diaphragm electrode, and for this outcrop to turn that metal plate to the upper wall section side of a case, and to attach a diaphragm in a case. Although the piezoelectric device of a diaphragm can also be turned and attached in the upper wall section side of a case, since the surface electrode and substrate of a piezoelectric device do not meet, it becomes difficult to connect the surface electrode of a piezoelectric device to the 2nd external electrode of a substrate in this case. On the other hand, if the metal plate of a diaphragm is turned to the upper wall section side of a case and it fixes, since the surface electrode and substrate of a piezoelectric device will meet, connection by the electroconductive glue of a surface electrode and the 2nd external electrode becomes easy. In

addition, since the outcrop of a metal plate is exposed to the one-side side of a diaphragm, connection between a metal plate and the 1st external electrode is also easy.

[0014] Like claim 4, the Young's modulus after hardening is 1x105 - 2x109 N/m2 as electroconductive glue with elasticity. If electroconductive glue is used, the effectiveness which was excellent in shock resistance and a sound pressure property will be demonstrated. In this case, the Vickers hardness after hardening is set to about 30-100.

[0015] It is desirable for the supporting material which supports two sides which a diaphragm counters to a supporter like claim 5 to consist of same ingredients as an elastic sealing agent, i.e., to apply an elastic sealing agent to all four sides of a diaphragm. That is, while an air leak is lost by closing the perimeter of a diaphragm with an elastic sealing agent, a sound pressure property also improves.

[0016] If piezo-electric sound components are manufactured at a process like claim 6, electrical installation with the external electrode of a piezo-electric plate and a substrate can be further performed at immobilization with a diaphragm and a case, immobilization with a case and a substrate, and few [it is of the same kind, and] processes, and a piezo-electric sound component according to claim 1 can be manufactured cheaply. Similarly, if piezo-electric sound components are manufactured by approach like claim 7, a piezo-electric sound component according to claim 2 can be manufactured cheaply.

[0017]

[Embodiment of the Invention] Drawing 3 - drawing 6 show the piezo-electric sound components of the surface mount mold which is the 1st operation gestalt of this invention. This piezo-electric sound component fits the application as an earphone, and consists of the diaphragms 1, the cases 4, and substrates 10 of a profile and a uni-morph mold.

[0018] It has electrode 2a of a thin film or a thick film, and 2b at the front rear face, and the piezoelectric device 2, the piezoelectric device 2, and width method

of the rectangle by which polarization processing was carried out in the thickness direction are the same, and are formed in a rectangle with a little long die-length dimension, and the diaphragm 1 is constituted from a metal plate 3 by which confrontation adhesion was carried out through electroconductive glue etc. by rear-face electrode 2b of a piezoelectric device 2, as shown in drawing 6 . In addition, rear-face electrode 2b is joining to the rear face of a piezoelectric device 2 directly through electroconductive glue etc., and may omit a metal plate 3. With this operation gestalt, the location where the piezoelectric device 2 inclined toward the one-side side of the die-length direction to the metal plate 3 is pasted, and it has outcrop 3a which the metal plate 3 exposed in the other side side of the die-length direction of a metal plate 3.

[0019] As a piezoelectric device 2, electrostrictive ceramics, such as PZT, is used, for example. Moreover, a metal plate 3 has the desirable ingredient which combines right conductivity and spring elasticity, and its ingredient especially with as near Young's modulus as a piezoelectric device 2 is desirable. Therefore, phosphor bronze, 42nickel, etc. are used, for example. In addition, since ceramics (PZT etc.) and the coefficient of thermal expansion are near when a metal plate 3 is 42nickel, what has more high dependability is obtained.

[0020] The above-mentioned diaphragm 1 can be manufactured at the following processes. First, it pierces from a ceramic green sheet, and after piercing a square-like parent substrate and working electrode formation, polarization, etc. to this parent substrate with metal mold, a parent substrate is pasted up on the motherboard of a metal plate with electroconductive glue etc. And the parent substrate and mother metal plate which were pasted up can be cut in the shape of a square by the cutline in every direction using a dicer etc., and a diaphragm can be obtained. Thus, there is an advantage that ingredient effectiveness and productive efficiency are good and can reduce facility cost by using the square-like metal plate 3 and the square-like piezoelectric device 2.

[0021] The above-mentioned diaphragm 1 is contained inside the case 4. That is, a case 4 is formed in the core box which has upper wall section 4a and four side-

attachment-walls sections 4b with insulating ingredients, such as ceramics or resin, and supporter 4c of the shape of a level difference which supports the both ends of a diaphragm 1 inside [which counter / two] side-attachment-wall section 4b is formed in one. In addition, since the smaller possible one raises sound pressure and can make resonance frequency small, supporter 4c is desirable. When it constitutes a case 4 from resin, heat-resistant resin, such as LCP (liquid crystal polymer), SPS (syndiotactic polystyrene), PPS (polyphenylene sulfide), and epoxy, is desirable. 4d of sound emission holes is formed in the center section of upper wall section 4a, slot 4e is formed in two opening edges of side-attachment-wall section 4b which counter, and 4f of notches for braking is formed in the one remaining opening edges of side-attachment-wall section 4b. The above-mentioned slot 4e is formed in the external electrodes 13 and 14 of the substrate 10 mentioned later, and a corresponding location.

[0022] It is contained inside a case 4, and two sides by the side of the shorter side of a diaphragm 1 are put on supporter 4c, and are being fixed with the elastic sealing agent 6 so that, as for a diaphragm 1, the metal plate 3 may meet upper wall section 4a (refer to drawing 4). What is necessary is just to use well-known elastic sealing agents, such as an urethane system and a silicone system, as this elastic sealing agent 6. Moreover, between two sides by the side of the long side of a diaphragm 1, and the inside of a case 4, few clearances are vacant, and the closure also of this clearance is carried out with the elastic sealing agent 6. That is, the closure of the perimeter of a diaphragm 1 is fixed and carried out to the case 4 with the elastic sealing agent 6. Thereby, the sound space 7 is formed between a diaphragm 1 and upper wall section 4a of a case 4.

[0023] The case 4 which attached the diaphragm 1 as mentioned above is pasted up on the substrate 10 with the insulating adhesives 19. When a substrate 10 is formed in rectangle plate-like with insulating ingredients, such as ceramics or resin, and it forms by resin, heat-resistant resin, such as LCP, SPS, PPS, and epoxy (glass epoxy is included), is used. The external electrodes 13 and 14 prolonged from a front face to a rear face through the through hole slots

11 and 12 are formed in the both ends of the longitudinal direction of a substrate 10. Outcrop 3a of a metal plate 3 and surface electrode 2a of a piezoelectric device 2 which are the diaphragm polar zone located in the both ends of a diaphragm 1 are electrically connected with the external electrodes 13 and 14 by conductive paste 15 and 16, respectively. In addition, it is avoidable for conductive paste 15 and 16 to be able to secure predetermined thickness, to be crushed by the case 4, and to disconnect it by entering into slot 4e formed in the opening edge of a case 4. Conductive paste 15 and 16 consists of electroconductive glue with soft elasticity, such as for example, an urethane system or a silicone system, and the thing of 1x105 - 2x109 N/m2 (Vickers hardness is 30-100) is used for the Young's modulus after the hardening. Moreover, in order that the coverage of conductive paste 15 and 16 may suppress the sound pressure fall by the excess of coverage, it is desirable respectively to suppose [about / 2.5mg**0.5mg] that it is little.

[0024] If predetermined signalling frequency (an AC signal or square wave signal) is impressed between the external electrode 13 prepared in the substrate 10, and 14, since the die-length direction both ends of a diaphragm 1 are supported by supporter 4c of a case 4 and the crosswise both ends of a diaphragm 1 are held free [elastic displacement] with the elastic sealing agent 6, a diaphragm 1 can vibrate in die-length bending mode considering the die-length direction both ends as the supporting point, and can generate a predetermined sound. A sound is emitted to the exterior from 4d of sound emission holes of a case 4.

[0025] The result of having performed the drop test of the piezo-electric sound components which consist of the above-mentioned configuration is shown below.

[Drop test]

Conditions: Piezo-electric sound components were attached in the 100g fixture, and the open-circuit situation of the conductive paste 15 and 16 when dropping a Z direction (level in a substrate) on a wood slab from height of 150cm was inspected.

the case where ten :Z direction O.K. epoxy system electroconductive glue is used when urethane system electroconductive glue is used -- four :Z directions -- poor flow (opening) generating -- when the urethane system electroconductive glue which has soft elasticity as mentioned above as conductive paste 15 and 16 for connecting the electrode of a diaphragm 1 and the external electrodes 13 and 14 of a substrate 10 is used, it turns out that it has the engine performance which was excellent in shock resistance. the Young's modulus of the urethane system electroconductive glue used at this time -- 1x109 N/m2 it is -- the Young's modulus of epoxy system electroconductive glue -- 5x109 N/m2 it was .

[0026] Next, the assembly approach of the above-mentioned piezo-electric sound components is explained according to drawing 7 and drawing 8 . As first shown in drawing 7 , it contains so that a metal plate 3 may turn to the upper wall section 4a side of a case 4 inside the case 4 which made the diaphragm 1 inside-out, and two sides by the side of the die-length direction both ends, i.e., a shorter side, are laid on supporter 4c. The perimeter of a diaphragm 1 is made to apply and harden the elastic sealing agent 6 by a dispenser etc. in this condition. Thereby, as shown in (a) of drawing 8 , the case 4 which attached the diaphragm 1 inside is acquired. Next, it applies to slot 4e formed in the opening edge of a case 4 from outcrop 3a of a metal plate 3 located in the end of a diaphragm 1 as shown in (b) of drawing 8 , and conductive paste 15 is applied continuously. It applies to slot 4e which similarly was formed in the opening edge of a case 4 from surface electrode 2a of a piezoelectric device 2 located in the other end of a diaphragm 1, and conductive paste 16 is applied continuously. In this case, flow dependability can be raised by applying conductive paste 15 and 16 in the shape of [three-dimensional] a key mold, without increasing coverage. As mentioned above, since a diaphragm 1 turns a metal plate 3 to the upper wall section 4a side of a case 4 and is being fixed, outcrop 3a of a metal plate 3 and surface electrode 2a of a piezoelectric device 2 which are two diaphragm electrodes will be exposed to the opening side of a case 4. Therefore, conductive paste 15 and 16 can draw out to the exterior easily. Next, as shown in (c) of drawing 8 , the

insulating adhesives 19 are applied to the opening edge except slot 4e of a case 4. In addition, the spreading process of adhesives 19 can also be performed before spreading of conductive paste 15 and 16. However, what is necessary is just to apply adhesives 19 to the part except slot 4e by the pattern predetermined by printing, imprint, etc. so that adhesives 19 and conductive paste 15 and 16 may not lap in this case. Next, as shown in (d) of drawing 8 , before conductive paste 15 and 16 and adhesives 19 harden, a substrate 10 is pasted up on a case 4. While adhesives 19 stick to the front face of a substrate 10 at this time, conductive paste 15 and 16 sticks to the external electrodes 13 and 14, respectively. In this condition, while a case 4 and a substrate 10 are unified by heat hardening or carrying out natural hardening in conductive paste 15 and 16 and the insulating adhesives 19, outcrop 3a of a metal plate 3 and the external electrode 13 of a substrate 10 are connected by conductive paste 15, and surface electrode 2a of a piezoelectric device 2 and the external electrode 14 of a substrate 10 are connected by conductive paste 16. In this way, piezo-electric sound components are completed.

[0027] In the above-mentioned operation gestalt, although the perimeter of a diaphragm 1 was supported / closed with the elastic sealing agent 6, two sides by the side of the shorter side of a diaphragm 1 may be fixed to supporter 4c with adhesives. However, since the direction which used the elastic sealing agent 6 can prevent more certainly the air leak between the side front of a diaphragm 1, and a background while a diaphragm 1 can vibrate freely, it is desirable on a sound pressure property.

[0028] Drawing 9 shows the piezo-electric sound components which are the 2nd operation gestalt of this invention. This piezo-electric sound component consists of the diaphragms 1, the cases 40, and substrates 10 of a profile and a uni-morph mold. The diaphragm 1 and the substrate 10 are the same as that of what was used with the 1st operation gestalt. Drawing 9 is the perspective view seen from the background, and the level difference-like supporter 41 is continuously formed in the medial-surface perimeter of a case 40. The top face of this

supporter 41 is formed in the same height, and the four-side perimeter of a diaphragm 1 is being fixed by the supporting material 42, such as adhesives, on the supporter 41. In addition, the same sign is given to the same part as the case 4 of drawing 7 , and duplication explanation is omitted. By being used with single frequency like a sounder or a ringer, restraining the perimeter of a diaphragm 1 with supporting material 42, and using a diaphragm 1 in a resonance field, the piezo-electric sound components of this operation gestalt can be strongly excited in area crookedness mode, and can obtain the amount of Oto.

[0029] Drawing 10 shows the 2nd operation gestalt of a diaphragm. Although this diaphragm 20 is the diaphragm 1 shown in drawing 6 , and a uni-morph mold diaphragm which pasted up the piezoelectric device 22 on one side of a metal plate 21 similarly, both the metal plate 21 and the piezoelectric device 22 are formed in the rectangle of the same configuration. And 1st electrode 22a is formed in the front face of a piezoelectric device 22 from the end just before the other end, and 2nd electrode 22b through which it flows through a metal plate 21 and an end face is formed in the other end side. Since two electrodes 22a and 22b are exposed to the front face of a diaphragm 20 also in this case, it can pull out to the exterior easily by conductive paste by turning and attaching a metal plate 21 side in upper wall section 4a of a case 4 like drawing 4 . The conductive paste in this case as well as the 1st operation gestalt should just use electroconductive glue with elasticity.

[0030] Drawing 11 and drawing 12 show the 3rd operation gestalt of a diaphragm. This diaphragm 30 carries out the laminating of the two-layer electrostrictive ceramics layers 31 and 32, the principal plane electrodes 33 and 34 are formed in the front flesh-side principal plane of a diaphragm 30, and the internal electrode 35 is formed among the ceramic layers 31 and 32. As a thick wire arrow head shows to drawing 12 , in the thickness direction, polarization of the two ceramic layers 31 and 32 is carried out in the same direction. The principal plane electrode 33 on a side front and the principal plane electrode 34 on a background are the shorter sides and these width of face of a diaphragm 30, and

are formed a little shorter than a long side, and the end is connected to the end-face electrode 36 formed in one shorter side side edge side of a diaphragm 30. Therefore, the principal plane electrodes 33 and 34 of a front flesh side are connected mutually. The internal electrode 35 was mostly formed in the symmetry configuration with the principal plane electrodes 33 and 34, it is separated from the end of an internal electrode 35 of the internal electrode with the above-mentioned end-face electrode 36, and the other end is connected to the end-face electrode 37 formed in the shorter side side edge side of another side of a diaphragm 30. In addition, the end-face electrode 37 and the flowing narrow width auxiliary electrode 38 are formed in the vertical side of the shorter side side edge section of another side of a diaphragm 30.

[0031] Receipt immobilization is carried out at a case and a case pastes up the above-mentioned diaphragm 30 as well as drawing 4 on a substrate. At this time, one side of the principal plane electrodes 33 and 34 is connected with one external electrode of a substrate by the conductive paste which has elasticity, and an auxiliary electrode 38 is connected with the external electrode of another side of a substrate by the conductive paste which has elasticity. And crookedness vibration of the diaphragm 30 can be carried out in die-length bending mode by impressing a predetermined alternation electrical potential difference between external electrodes. That is, crookedness vibration can be carried out, being able to use the shorter side side both ends of a diaphragm 30 as the supporting point, and being able to use the center section of the longitudinal direction as a maximum amplitude point. In the case of this operation gestalt, it is the laminated structure which does not have a metal plate, and since two oscillating fields arranged in order in the thickness direction vibrate to hard flow mutually, compared with a uni-morph mold diaphragm, the big amount of displacement, i.e., big sound pressure, can be obtained.

[0032] Drawing 13 shows the 4th operation gestalt of a diaphragm. This diaphragm 50 carries out the laminating of the three-layer electrostrictive ceramics layers 51-53, the principal plane electrodes 54 and 55 are formed in the

front rear face of a diaphragm 50, and internal electrodes 56 and 57 are formed among each ceramic layers 51-53. As a thick wire arrow head shows, in the thickness direction, polarization of the three ceramic layers 51-53 is carried out in the same direction. The principal plane electrodes 54 and 55 are the shorter sides and these width of face of a diaphragm 50, and are formed a little shorter than a long side, and the end is connected to the end-face electrode 58 formed in one shorter side side edge side of a diaphragm 50. Therefore, the principal plane electrodes 54 and 55 of a front flesh side are connected mutually. It is separated from the end of internal electrodes 56 and 57 with the end-face electrode 58, and the other end is connected to the end-face electrode 59 formed in the shorter side side edge side of another side of a diaphragm 50. Therefore, internal electrodes 56 and 57 are also connected mutually. In addition, the end-face electrode 59 and narrow width auxiliary-electrode 59a through which it flows are formed in the vertical side of the shorter side side edge section of another side of a diaphragm 50. Like [this diaphragm 50] drawing 4 , receipt immobilization is carried out at a case and a case is pasted up on a substrate. At this time, one side of the principal plane electrodes 54 and 55 is connected with one external electrode of a substrate by the conductive paste which has elasticity, and auxiliary-electrode 59a is connected with the external electrode of another side of a substrate by the conductive paste which has elasticity.

[0033] For example, if the electrical potential difference of minus and the electrical potential difference of plus in auxiliary-electrode 59a are impressed to the principal plane electrode 54, the electric field of the direction shown by the thin line arrow head of drawing 13 will arise. Since the internal electrodes 56 and 57 located in the both sides of the ceramic layer 52 which is an interlayer at this time are the same potentials, electric field do not produce them. Since the direction of polarization and the direction of electric field are the same directions, the ceramic layer 51 on a side front is shrunken in the direction of a flat surface, and since the direction of polarization and the direction of electric field are hard flow, the ceramic layer 52 on a background is extended in the direction of a flat

surface. And an interlayer 52 is not expanded and contracted. Therefore, a diaphragm 50 is crooked so that it may become a convex to a lower part. If an alternation electrical potential difference is impressed between the end-face electrode 58 and 59, a diaphragm 50 can produce crookedness vibration periodically and can generate the sound of big sound pressure by this.

[0034] In addition, a metal plate and a piezoelectric device may be not only a rectangle but squares. Moreover, although the above-mentioned operation gestalt explained the uni-morph mold diaphragm which stuck the piezoelectric device on one side of a metal plate, and the laminating mold diaphragm which carried out the laminating of the piezoelectric device, the 1st and 2nd diaphragm electrode is exposed to the one side side of both ends, and as long as it is the piezo-electric diaphragm of the square which vibrates in die-length bending mode or area crookedness mode, what kind of piezo-electric diaphragm may be used. As piezo-electric sound components of this invention, there are a piezo-electric buzzer, a piezo-electric earphone, a piezoelectric loudspeaker, a piezo-electric sounder, a ringer, etc.

[0035]

[Effect of the Invention] The metal mold in the process from punching of a green sheet to [so that clearly / since the square-like diaphragm was used according to invention according to claim 1] a parent substrate cut, a fixture, and a piezo electric crystal form can be lessened in the above explanation, and since ingredient effectiveness is good, productive efficiency improves and a manufacturing cost can be reduced. moreover -- since two sides which a square-like diaphragm counters are supported to the supporter of a case, the clearance between other two sides and cases of a diaphragm is closed and it was made to make it vibrate in die-length bending mode -- max -- a variation rate -- a point -- the center line of the die-length direction of a diaphragm -- meeting -- existing -- a variation rate -- the volume can be enlarged. Therefore, sound conversion efficiency can be raised compared with a disc-like diaphragm. And although, as for a square-like diaphragm, the two sides are supported, since a part in the

meantime can be displaced freely, a low frequency can be obtained compared with a disc-like diaphragm. On the contrary, a dimension can be miniaturized if the same frequency is obtained. Furthermore, since the electroconductive glue which connects a diaphragm electrode and the external electrode of a substrate has elasticity, even if it drops the device carrying these piezo-electric sound components accidentally and a big impact load is added, electroconductive glue absorbs an impact and a possibility that between a diaphragm electrode and external electrodes may be disconnected can be canceled. Moreover, since the Young's modulus after hardening of electroconductive glue is low, vibration of a diaphragm is not barred but it has the effectiveness that a sound pressure property improves.

[0036] Moreover, in invention according to claim 2, since four sides of a square-like diaphragm are supported to the supporter of a case and it was made to make it vibrate in area crookedness mode, the piezo-electric sound components suitable for the sounder used in a resonance field, a ringer, etc. are realizable. Since the diaphragm electrode and the external electrode of a substrate were connected like claim 1 also in this case with the electroconductive glue which has elasticity, shock-proof ability improves, it is small and the piezo-electric sound components excellent in the sound pressure property can be realized.

[0037] Moreover, since electrical installation of a diaphragm electrode and an external electrode is also performed at the same time it pastes up a case and a substrate while spreading of the electroconductive glue which connects a diaphragm electrode and the external electrode of a substrate becomes easy, since a diaphragm is attached like claims 6 and 7 so that two diaphragm electrodes may be exposed from opening of a case, a production process can be simplified and the processing time of a process can be shortened. Therefore, the piezo-electric sound components of claims 1 and 2 can be manufactured cheaply.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the comparison Fig. [diaphragm / a circular diaphragm and / square] of displacement distribution.
[Drawing 2] It is drawing showing the relation between the dimension of a circular diaphragm and a square diaphragm, and resonance frequency.
[Drawing 3] It is the perspective view of the 1st operation gestalt of the piezo-electric sound components concerning this invention.
[Drawing 4] It is X-X-ray sectional view of drawing 3 .
[Drawing 5] It is the Y-Y line sectional view of drawing 3 .
[Drawing 6] It is the perspective view of a diaphragm.
[Drawing 7] It is the decomposition perspective view which looked at the case and the diaphragm from the rear-face side.
[Drawing 8] It is process drawing showing the assembly approach of of the case and substrate incorporating a diaphragm.
[Drawing 9] It is the perspective view of the 2nd operation gestalt of the piezo-electric sound components concerning this invention.
[Drawing 10] It is the sectional view of the 2nd operation gestalt of a diaphragm.
[Drawing 11] It is the perspective view of the 3rd operation gestalt of a diaphragm.
[Drawing 12] It is the sectional view of the diaphragm shown in drawing 11 .

[Drawing 13] It is the sectional view of the 4th operation gestalt of a diaphragm.

[Description of Notations]

1 Diaphragm

2 Piezoelectric Device

2a Surface electrode

3 Metal Plate

4 Case

4a Upper wall section

4b Side-attachment-wall section

4c Supporter

6 Elastic Sealing Agent

10 Substrate

13 14 External electrode

15 16 Conductive paste (electroconductive glue with elasticity)

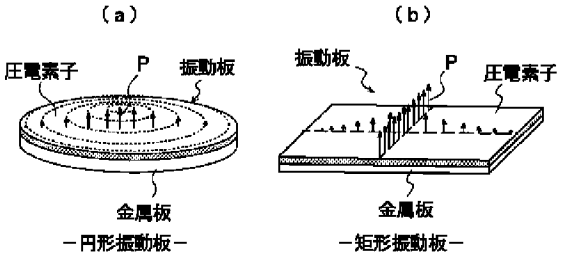
19 Insulating Adhesives

[Translation done.]

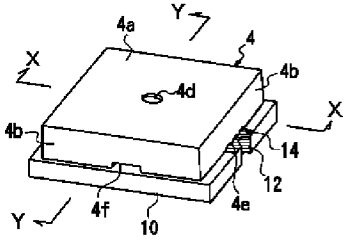
* NOTICES *

DRAWINGS

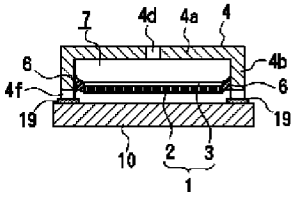
[Drawing 1]



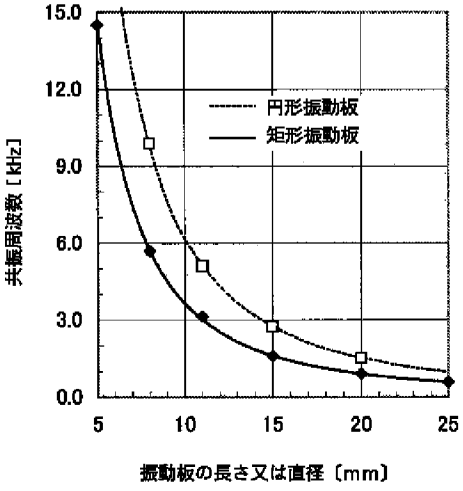
[Drawing 3]



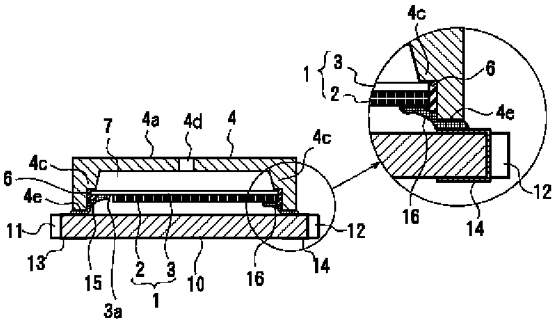
[Drawing 5]



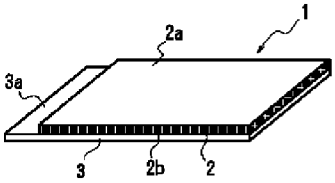
[Drawing 2]



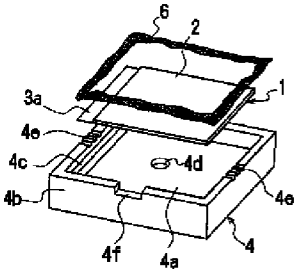
[Drawing 4]



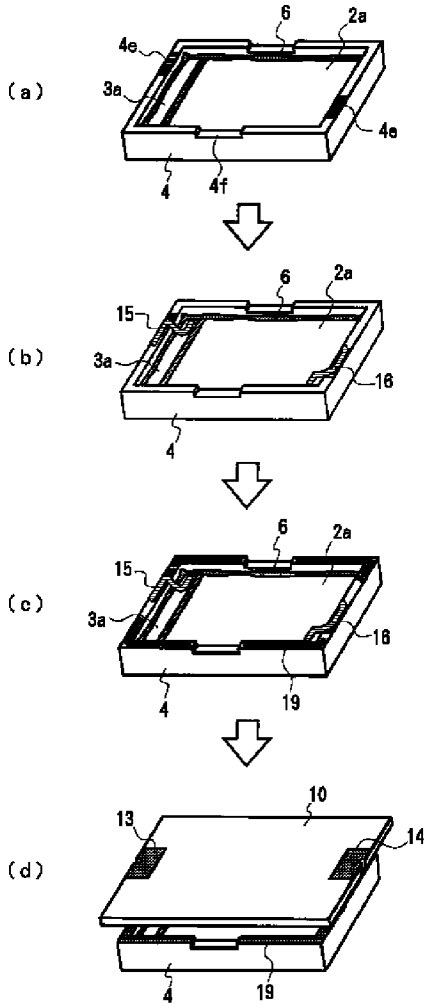
[Drawing 6]



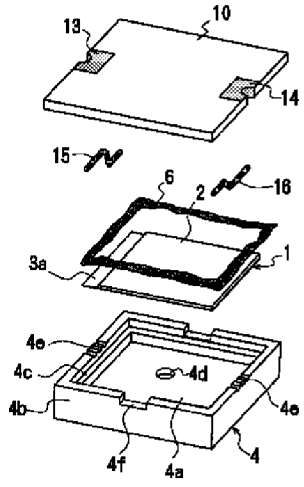
[Drawing 7]



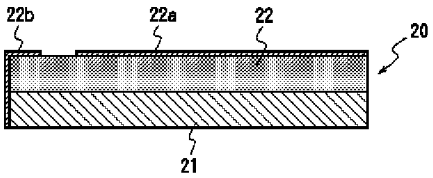
[Drawing 8]



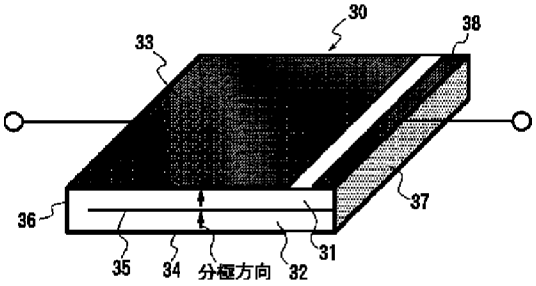
[Drawing 9]



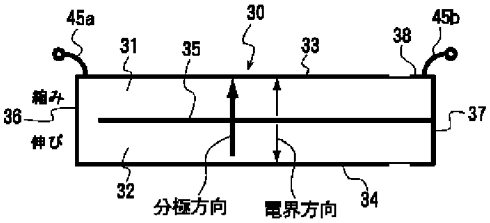
[Drawing 10]



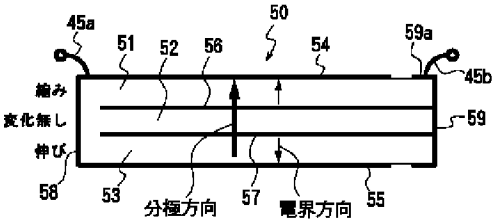
[Drawing 11]



[Drawing 12]



[Drawing 13]



[Translation done.]

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Ｈ０１Ｌ　23/02		Ｈ０１Ｌ　23/02	Ｋ	
41/09		41/08	Ｕ	
41/22			Ｃ	
		41/22	Ｚ	

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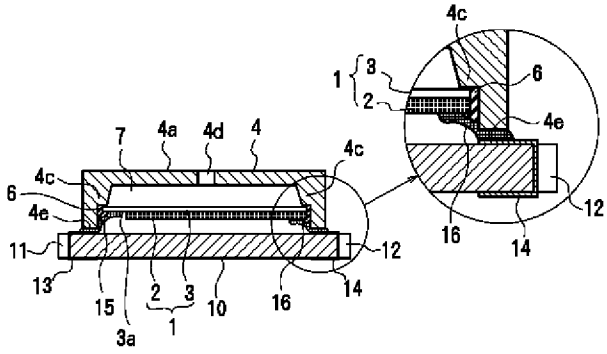
Ｆターム(参考)　5D004 AA01 AA09 BB01 CC01 CC06 DD01 FF05 FF06 FF09

(54)【発明の名称】　圧電音響部品およびその製造方法

(57)【要約】
【課題】生産効率が高く、音響変換効率が良好で、小型に構成できるとともに、耐衝撃性にも優れた圧電音響部品を得る。
【解決手段】四角形の金属板３に四角形の圧電素子２を貼り付けてユニモルフ型振動板１を構成し、この振動板１の長さ方向両端部をケース４の対向する２つの側壁部４ｂの内側に形成された支持部４ｃに支持し、振動板１の残りの２辺とケース４との隙間を弾性封止材６で封止する。外部電極１３，１４を有する基板１０上にケース４を接着し、金属板３を外部電極１３に対して弾性を持つ導電ペースト１５で接続し、圧電素子２の表面電極２ａを外部電極１４に対して弾性を持つ導電ペースト１６で接続する。これにより、衝撃に対して振動板１と基板１０の外部端子１３，１４との接続信頼性が高くなる。



【特許請求の範囲】

【請求項１】両端部の片面側に第１，第２の振動板電極が露出し、長さベンディングモードで振動する四角形の圧電振動板と、上壁部と４つの側壁部とを有し、対向する２つの側壁部の内側に支持部を持つ絶縁性ケースと、第１と第２の外部電極が形成された平板状の基板とを備え、上記振動板はケース内に第１，第２の振動板電極が露出する面がケースの上壁部と反対側を向くように収納され、振動板の対向する２辺が上記支持部に対して支持材で支持され、振動板の残りの２辺とケースとの隙間が弾性封止材で封止されて、振動板とケースの上壁部との間に音響空間が形成され、上記基板上に上記ケースの側壁部開口端が接着されるとともに、上記振動板の第１の振動板電極は弾性を持つ導電性接着剤により第１の外部電極と電気的に接続され、かつ上記第２の振動板電極は弾性を持つ導電性接着剤により第２の外部電極と電気的に接続されていることを特徴とする圧電音響部品。

【請求項２】両端部の片面側に第１，第２の振動板電極が露出し、面積屈曲モードで振動する四角形の圧電振動板と、上壁部と４つの側壁部とを有し、４つの側壁部の内側に支持部を持つ絶縁性ケースと、第１と第２の外部電極が形成された平板状の基板とを備え、上記振動板はケース内に第１，第２の振動板電極が露出する面がケースの上壁部と反対側を向くように収納され、振動板の４辺が上記支持部に対して支持材で支持されて、振動板とケースの上壁部との間に音響空間が形成され、上記基板上に上記ケースの側壁部開口端が接着されるとともに、上記振動板の第１の振動板電極は弾性を持つ導電性接着剤により第１の外部電極と電気的に接続され、かつ上記第２の振動板電極は弾性を持つ導電性接着剤により第２の外部電極と電気的に接続されていることを特徴とする圧電音響部品。

【請求項３】上記振動板は、金属板の片面に、かつケースの支持部に支持される一方の辺側に偏った位置に圧電素子が接着されたユニモルフ型圧電振動板であり、外部に露出した圧電素子の片面の電極が第１の振動板電極を構成するとともに、上記振動板の圧電素子が接着された面の他辺側に金属板の露出部が設けられ、この露出部が第２の振動板電極を構成し、上記振動板はその金属板をケースの上壁部側に向けてケースに取り付けられていることを特徴とする請求項１または２に記載の圧電音響部品。

【請求項４】上記弾性を持つ導電性接着剤は、硬化後のヤング率が1×10^{5}～2×10^{9} N／m^{2}の導電性接着剤であることを特徴とする請求項１ないし３のいずれかに記載の圧電音響部品。

【請求項５】上記振動板の対向する２辺を上記支持部に対して支持する支持材は、弾性封止材と同一材料で構成されていることを特徴とする請求項１，３，４のいずれかに記載の圧電音響部品。

【請求項６】両端部の片面側に第１，第２の振動板電極が露出し、長さベンディングモードで振動する四角形の圧電振動板を準備する工程と、上壁部と４つの側壁部とを有し、対向する２つの側壁部の内側に支持部を持つ絶縁性ケースを準備する工程と、第１と第２の外部電極が形成された平板状の基板を準備する工程と、上記振動板をケース内に第１，第２の振動板電極が露出する面がケースの上壁部と反対側を向くように収納し、振動板の対向する２辺を上記支持部に対して支持材で支持するとともに、振動板の残りの２辺とケースとの隙間を弾性封止材で封止し、振動板とケースの上壁部との間に音響空間を形成する工程と、上記振動板の第１の振動板電極からケースの側壁部開口端まで弾性を持つ導電性接着剤を連続的に塗布する工程と、上記振動板の第２の振動板電極からケースの側壁部開口端まで弾性を持つ導電性接着剤を連続的に塗布する工程と、上記基板上面または上記ケースの側壁部開口端に絶縁性接着剤を塗布する工程と、上記基板上にケースの側壁部開口端を絶縁性接着剤により接着すると同時に、導電性接着剤により第１の振動板電極と第１の外部電極、第２の振動板電極と第２の外部電極とを相互に接続する工程と、上記絶縁性接着剤および導電性接着剤を同時に硬化させる工程と、を備える圧電音響部品の製造方法。

【請求項７】両端部の片面側に第１，第２の振動板電極が露出し、面積屈曲モードで振動する四角形の圧電振動板を準備する工程と、上壁部と４つの側壁部とを有し、４つの側壁部の内側に支持部を持つ絶縁性ケースを準備する工程と、第１と第２の外部電極が形成された平板状の基板を準備する工程と、上記振動板をケース内に第１，第２の振動板電極が露出する面がケースの上壁部と反対側を向くように収納し、振動板の４辺を上記支持部に対して支持材で支持し、振動板とケースの上壁部との間に音響空間を形成する工程と、上記振動板の第１の振動板電極からケースの側壁部開口端まで弾性を持つ導電性接着剤を連続的に塗布する工程と、上記振動板の第２の振動板電極からケースの側壁部開口端まで弾性を持つ導電性接着剤を連続的に塗布する工程と、上記基板上面または上記ケースの側壁部開口端に絶縁性接着剤を塗布する工程と、上記基板上にケースの側壁部開口端を絶縁性接着剤により接着すると同時に、導電性接着剤により第１の振動板電極と第１の外部電極、第２の振動板電極と第２の外部電極とを相互に接続する工程と、上記絶縁性接着剤および導電性接着剤を同時に硬化させる工程と、を備える圧電音響部品の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は圧電ブザーや圧電受話器などの圧電音響部品およびその製造方法に関するものである。

【０００２】

【従来の技術】従来、電子機器、家電製品、携帯電話機などにおいて、警報音や動作音を発生する圧電ブザーあるいは圧電受話器として圧電音響部品が広く用いられている。この種の圧電音響部品は、円形の金属板の片面に円形の圧電素子を貼り付けてユニモルフ型振動板を構成し、金属板の周縁部を円形のケースの中にシリコーンゴムを用いて支持するとともに、ケースの開口部をカバー（図示せず）で閉鎖した構造のものが一般的である。しかしながら、円形の振動板を用いると、生産効率が悪く、音響変換効率が低く、しかも小型に構成することが難しいという問題点があった。

【０００３】そこで、本出願人は、四角形の振動板を用いることで、生産効率の向上、音響変換効率の向上および小型化を可能とした圧電音響部品を提案した（特願平１１－２９３２０４号）。この圧電音響部品は、四角形の金属板の片面に四角形の圧電素子を貼り付けた振動板と、上壁部と４つの側壁部とを有し、対向する２つの側壁部の内側に支持部を持つ絶縁性ケースと、第１と第２の外部電極が形成された平板状の基板とを備えたものであり、ケース内に振動板が収納され、振動板の対向する２辺と支持部とが支持材で固定され、振動板の残りの２辺とケースとの隙間が弾性封止材で封止されて、振動板とケースの上壁部との間に音響空間が形成される。そして、基板上にケースの側壁部開口端が接着されるとともに、金属板が第１の外部電極に対して電気的に接続され、かつ圧電素子の電極は第２の外部電極に対して電気的に接続される。

【０００４】

【発明が解決しようとする課題】現在、電子部品ではリフロー半田付けによる表面実装が一般化しており、機械による部品組立が主流になっているが、圧電音響部品も表面実装型に構成することが望まれている。そのためには、振動板と基板の外部電極とを導電性接着剤を用いて電気的に接続するのが望ましい。ところが、一般に使用されているエポキシ系の導電性接着剤を使用すると、音圧特性および耐衝撃性の点で十分な性能が得られない場合があった。即ち、携帯電話機などの携帯機器の場合、誤って落下させたりして大きな衝撃荷重が加わることがあり、エポキシ系導電性接着剤を使用すると、衝撃荷重によってクラックが入り、振動板と基板の外部電極との間が断線してしまう。

【０００５】そこで、本発明の目的は、生産効率が高く、音響変換効率が良好で、小型に構成できるとともに、耐衝撃性にも優れた圧電音響部品を得ることにある。

【０００６】

【課題を解決するための手段】上記目的を達成するため、請求項１に記載の発明は、両端部の片面側に第１，第２の振動板電極が露出し、長さベンディングモードで振動する四角形の圧電振動板と、上壁部と４つの側壁部とを有し、対向する２つの側壁部の内側に支持部を持つ絶縁性ケースと、第１と第２の外部電極が形成された平板状の基板とを備え、上記振動板はケース内に第１，第２の振動板電極が露出する面がケースの上壁部と反対側を向くように収納され、振動板の対向する２辺が上記支持部に対して支持材で支持され、振動板の残りの２辺とケースとの隙間が弾性封止材で封止されて、振動板とケースの上壁部との間に音響空間が形成され、上記基板上に上記ケースの側壁部開口端が接着されるとともに、上記振動板の第１の振動板電極は弾性を持つ導電性接着剤により第１の外部電極と電気的に接続され、かつ上記第２の振動板電極は弾性を持つ導電性接着剤により第２の外部電極と電気的に接続されていることを特徴とする圧電音響部品を提供する。また、請求項２に記載の発明は、両端部の片面側に第１，第２の振動板電極が露出し、面積屈曲モードで振動する四角形の圧電振動板と、上壁部と４つの側壁部とを有し、４つの側壁部の内側に支持部を持つ絶縁性ケースと、第１と第２の外部電極が形成された平板状の基板とを備え、上記振動板はケース内に第１，第２の振動板電極が露出する面がケースの上壁部と反対側を向くように収納され、振動板の４辺が上記支持部に対して支持材で支持されて、振動板とケースの上壁部との間に音響空間が形成され、上記基板上に上記ケースの側壁部開口端が接着されるとともに、上記振動板の第１の振動板電極は弾性を持つ導電性接着剤により第１の外部電極と電気的に接続され、かつ上記第２の振動板電極は弾性を持つ導電性接着剤により第２の外部電極と電気的に接続されていることを特徴とする圧電音響部品を提供する。また、請求項６に記載の発明は、両端部の片面側に第１，第２の振動板電極が露出し、長さベンディングモードで振動する四角形の圧電振動板を準備する工程と、上壁部と４つの側壁部とを有し、対向する２つの側壁部の内側に支持部を持つ絶縁性ケースを準備する工程と、第１と第２の外部電極が形成された平板状の基板を準備する工程と、上記振動板をケース内に第１，第２の振動板電極が露出する面がケースの上壁部と反対側を向くように収納し、振動板の対向する２辺を上記支持部に対して支持材で支持するとともに、振動板の残りの２辺とケースとの隙間を弾性封止材で封止し、振動板とケースの上壁部との間に音響空間を形成する工程と、上記振動板の第１の振動板電極からケースの側壁部開口端まで弾性を持つ導電性接着剤を連続的に塗布する工程と、上記振動板の第２の振動板電極からケースの側壁部開口端まで弾性を持つ導電性接着剤を連続的に塗布する工程と、上記基板上面または上記ケースの側壁部開口端に絶縁性接着剤を塗布する工程と、上記基板上にケースの側壁部開口端を絶縁性接着剤により接着すると同時に、導電性接着剤により第１の振動板電極と第１の外部電極、第２の振動板電極と第２の外部電極とを相互に接続する工程と、上記絶縁性接着剤および導電性接着剤

を同時に硬化させる工程と、を備える圧電音響部品の製造方法を提供する。さらに、請求項７に記載の発明は、両端部の片面側に第１，第２の振動板電極が露出し、面積屈曲モードで振動する四角形の圧電振動板を準備する工程と、上壁部と４つの側壁部とを有し、４つの側壁部の内側に支持部を持つ絶縁性ケースを準備する工程と、第１と第２の外部電極が形成された平板状の基板を準備する工程と、上記振動板をケース内に第１，第２の振動板電極が露出する面がケースの上壁部と反対側を向くように収納し、振動板の４辺を上記支持部に対して支持材で支持し、振動板とケースの上壁部との間に音響空間を形成する工程と、上記振動板の第１の振動板電極からケースの側壁部開口端まで弾性を持つ導電性接着剤を連続的に塗布する工程と、上記振動板の第２の振動板電極からケースの側壁部開口端まで弾性を持つ導電性接着剤を連続的に塗布する工程と、上記基板上面または上記ケースの側壁部開口端に絶縁性接着剤を塗布する工程と、上記基板上にケースの側壁部開口端を絶縁性接着剤により接着すると同時に、導電性接着剤により第１の振動板電極と第１の外部電極、第２の振動板電極と第２の外部電極とを相互に接続する工程と、上記絶縁性接着剤および導電性接着剤を同時に硬化させる工程と、を備える圧電音響部品の製造方法を提供する。

【０００７】振動板を構成する圧電素子は四角形であるから、グリーンシートから圧電素子を打ち抜くにしても、抜きカスを少なくでき、材料効率が良い。また、親基板状態で電極形成，分極などの作業ができるので、生産効率がよい。さらに、設計的に必要な寸法は親基板カット寸法で決めるため、円板状圧電素子のようにグリーンシートの打ち抜き金型をその都度作成しなくてもよい。つまり、従来に比べてグリーンシートの打ち抜き～親基板カット工程における金型、治具、圧電体品種などを少なくできるので、投資金額、生産効率の面で有利である。

【０００８】請求項１に係る発明は、受話器としての用途に適した例であり、広いレンジの周波数に対応するため、共振領域だけでなく共振領域以外の領域も使用される。振動板の振動エネルギーが比較的小さくても変位できるように、四角形状の振動板の対向する２辺をケースの支持部に支持材で支持し、残りの２辺とケースとの隙間を弾性封止材で封止している。振動板の２つの振動板電極間に所定の周波数信号を入力すると、圧電素子が所定方向に伸縮し、これに応じて振動板は長さベンディングモードで屈曲変形する。このとき、振動板はケースに固定された両端部を節として上下に振動し、図１の（ｂ）に示すように、最大変位点Ｐが振動板の長さ方向の中心線に沿って存在する。なお、図１では説明を簡単にするため、ユニモルフ形振動板の例を示す。これに対し、円板状の振動板の場合には、図１の（ａ）のように中心部だけに最大変位点Ｐが存在する。つまり、四角形状の振動板の場合、変位体積が従来の円板状の振動板に比べて大きくなる。この変位体積は、空気を動かすエネルギーとなるので、音響変換効率を高めることができる。なお、振動板の幅方向両端部とケースとの隙間を封止材で封止しているが、封止材は弾性を持つので、振動板の変位を妨げず、音圧が低下することがない。さらに、振動板はその長さ方向両端部が固定されるが、その間の部分は自由に変位できるので、円板状の振動板に比べて低い周波数の音を得ることができる。逆に、同じ周波数の音を得るのであれば、寸法を小型化できる。

【０００９】一方、請求項２に係る発明は、サウンダやリンガなどの用途に適した例であり、単一周波数での大音量に対応するため、共振領域で使用される。振動板の振動エネルギーを大きくするべく、面積屈曲モードで励振させるため、四角形状の振動板の４辺すべてをケースの支持部に支持材で支持した構造となっている。なお、面積屈曲モードとは、振動板が長方形を含む四角形であり、振動板の主面をなす２つの対角線位置が最大変位となるように、つまり対角線の交点が最大変位量となるように振動板の面積全体が厚み方向に屈曲振動するものである。

【００１０】本発明において、支持材としては、エポキシ系接着剤のように硬化状態におけるヤング率が高く、振動板の端部を強く拘束するものでもよいし、シリコーンゴムなどの弾性封止材のように、硬化状態におけるヤング率が低く、振動板の拘束力が弱く、振動板の変位を許容するものであってもよい。

【００１１】図２は円形の振動板と四角形の振動板との寸法と共振周波数との関係を示す比較図である。この場合もユニモルフ型振動板を用いた。なお、比較に当たっては、圧電素子として厚みが５０μｍのＰＺＴを用い、金属板として厚みが５０μｍの４２Ｎｉを用いた。また、四角形振動板の長さＬと幅Ｗの比を１．６７とした。図から明らかなように、同一周波数であれば、四角形振動板は円形振動板に比べて寸法（長さ，直径）を小さくできる。逆に、寸法が同一であれば、低い周波数を得ることができる。

【００１２】本発明では、振動板を固定したケースは平板状の基板に接着固定される。そして、第１の振動板電極が基板の第１の外部電極に対して弾性を持つ導電性接着剤により電気的に接続され、第２の振動板電極が基板の第２の外部電極に対して弾性を持つ導電性接着剤により電気的に接続され、圧電音響部品が得られる。なお、基板に設けた第１，第２の外部電極を基板の裏面まで引き回すことにより、表面実装型に構成することができる。導電性接着剤が弾性を持つので、本圧電音響部品を搭載した機器を誤って落下させたりして大きな衝撃荷重が加わっても、クラックが入らず、振動板電極と外部電極との間が断線する恐れがない。また、導電性接着剤の硬化後のヤング率が低いので、振動板の振動を抑制する

ことがなく、音圧が低下しない。

【００１３】請求項３のように、振動板として、金属板の片面に、かつケースの支持部に支持される一方の辺側に偏った位置に圧電素子が接着されたユニモルフ型圧電振動板を用い、外部に露出した圧電素子の片面の電極が第１の振動板電極を構成するとともに、振動板の圧電素子が接着された面の他辺側に金属板の露出部が設けられ、この露出部が第２の振動板電極を構成し、振動板をその金属板をケースの上壁部側に向けてケースに取り付けるのが望ましい。振動板の圧電素子をケースの上壁部側に向けて取り付けることもできるが、この場合には、圧電素子の表面電極と基板とが対面しないので、圧電素子の表面電極を基板の第２外部電極に接続するのが難しくなる。これに対し、振動板の金属板をケースの上壁部側に向けて固定すれば、圧電素子の表面電極と基板とが対面するので、表面電極と第２の外部電極との導電性接着剤による接続が容易となる。なお、振動板の一辺側に金属板の露出部が露出しているので、金属板と第１の外部電極との接続も容易である。

【００１４】請求項４のように、弾性を持つ導電性接着剤としては、硬化後のヤング率が1×10^{5}～2×10^{9} Ｎ／m^{2} の導電性接着剤を用いれば、耐衝撃性および音圧特性において優れた効果を発揮する。この場合には、硬化後のビッカース硬度が約３０～１００となる。

【００１５】請求項５のように、振動板の対向する２辺を支持部に対して支持する支持材が弾性封止材と同一材料で構成されていること、つまり弾性封止材を振動板の４辺全てに塗布するのが望ましい。つまり、振動板の周囲を弾性封止材で封止することにより、空気漏れがなくなるとともに、音圧特性も向上する。

【００１６】請求項６のような工程で圧電音響部品を製造すれば、振動板とケースとの固定、ケースと基板との固定、さらに圧電板と基板の外部電極との電気的接続を、同種でかつ少ない工程で行なうことができ、請求項１に記載の圧電音響部品を安価に製造することができる。同様に、請求項７のような方法で圧電音響部品を製造すれば、請求項２に記載の圧電音響部品を安価に製造することができる。

【００１７】

【発明の実施の形態】図３～図６は本発明の第１の実施形態である表面実装型の圧電音響部品を示す。この圧電音響部品は、受話器としての用途に適したものであり、大略、ユニモルフ型の振動板１とケース４と基板１０とで構成されている。

【００１８】振動板１は、図６に示すように、表裏面に薄膜または厚膜の電極２ａ，２ｂを有し、厚み方向に分極処理された長方形の圧電素子２と、圧電素子２と幅寸法が同一で長さ寸法がやや長い長方形に形成され、圧電素子２の裏面電極２ｂに導電性接着剤などを介して対面接着された金属板３とで構成されている。なお、裏面電極２ｂは、金属板３を圧電素子２の裏面に導電性接着剤などを介して直接接合することで、省略してもよい。この実施形態では、圧電素子２が金属板３に対して長さ方向の一辺側へ偏った位置に接着されており、金属板３の長さ方向の他辺側には金属板３が露出した露出部３ａを有する。

【００１９】圧電素子２としては、例えばＰＺＴなどの圧電セラミックスが用いられる。また、金属板３は良導電性とバネ弾性とを兼ね備えた材料が望ましく、特にヤング率が圧電素子２と近い材料が望ましい。そのため、例えばリン青銅，４２Ｎｉなどが用いられる。なお、金属板３が４２Ｎｉの場合には、セラミック（ＰＺＴ等）と熱膨張係数が近いので、より信頼性の高いものが得られる。

【００２０】上記振動板１は次のような工程で製造することができる。まず、セラミックグリーンシートから打ち抜き金型によって四角形状の親基板を打ち抜き、この親基板に対して電極形成、分極などの作業を行なった後、親基板を金属板の母板に導電性接着剤などで接着する。そして、接着された親基板と母金属板とをダイサーなどを用いて縦横のカットラインで四角形状にカットし、振動板を得ることができる。このように、四角形状の金属板３と四角形状の圧電素子２とを用いることで、材料効率、生産効率がよく、設備コストを削減できるという利点がある。

【００２１】上記振動板１はケース４の内側に収納されている。すなわち、ケース４はセラミックスまたは樹脂などの絶縁性材料で上壁部４ａと４つの側壁部４ｂとを持つ箱型に形成され、対向する２つの側壁部４ｂの内側に振動板１の両端部を支持する段差状の支持部４ｃが一体に形成されている。なお、支持部４ｃはできるだけ小さい方が音圧を向上させ、共振周波数を小さくできるので、望ましい。ケース４を樹脂で構成する場合には、ＬＣＰ（液晶ポリマー），ＳＰＳ（シンジオタクチックポリスチレン），ＰＰＳ（ポリフェニレンサルファイド），エポキシなどの耐熱樹脂が望ましい。上壁部４ａの中央部には放音孔４ｄが形成され、対向する２つの側壁部４ｂの開口縁部には溝部４ｅが形成され、残りの１つの側壁部４ｂの開口縁部には制動用の切欠部４ｆが形成されている。上記溝部４ｅは、後述する基板１０の外部電極１３，１４と対応する位置に形成されている。

【００２２】振動板１はその金属板３が上壁部４ａと対面するように、ケース４の内部に収納され、振動板１の短辺側の２辺が支持部４ｃに載せられ、弾性封止材６で固定されている（図４参照）。この弾性封止材６としてはウレタン系，シリコーン系などの公知の弾性封止材を用いればよい。また、振動板１の長辺側の２辺とケース４の内面との間には僅かな隙間が空いており、この隙間も弾性封止材６によって封止されている。つまり、振動板１の全周が弾性封止材６によってケース４に固定さ

れ、封止されている。これにより、振動板１とケース４の上壁部４ａとの間に音響空間７が形成される。

【００２３】上記のように振動板１を取り付けたケース４は基板１０に、絶縁性の接着剤１９によって接着されている。基板１０はセラミックスまたは樹脂などの絶縁性材料で長方形平板状に形成され、樹脂で形成する場合にはＬＣＰ，ＳＰＳ，ＰＰＳ，エポキシ（ガラスエポキシを含む）などの耐熱樹脂が用いられる。基板１０の長手方向の両端部には、スルーホール溝１１，１２を介して表面から裏面へ延びる外部電極１３，１４が形成されている。振動板１の両端に位置する振動板電極部である金属板３の露出部３ａと圧電素子２の表面電極２ａは、それぞれ導電ペースト１５，１６によって、外部電極１３，１４と電気的に接続されている。なお、導電ペースト１５，１６はケース４の開口縁部に形成された溝部４ｅに入り込むことにより、所定の膜厚を確保でき、ケース４に押し潰されて断線するのを回避できる。導電ペースト１５，１６は、例えばウレタン系またはシリコーン系などの柔弾性を持つ導電性接着剤よりなり、その硬化後のヤング率が1×10^{5}～2×10^{9} Ｎ／m^{2}（ビッカース硬度が３０～１００）のものが使用される。また、導電ペースト１５，１６の塗布量は、塗布量過多による音圧低下を抑えるため、それぞれ２．５ｍｇ±０．５ｍｇ程度の少量とするのが望ましい。

【００２４】基板１０に設けられた外部電極１３，１４間に所定の周波数信号（交流信号または矩形波信号）を印加すれば、振動板１の長さ方向両端部がケース４の支持部４ｃに支持され、振動板１の幅方向両端部が弾性封止材６で弾性変位自在に保持されているので、振動板１は長さ方向両端部を支点として長さベンディングモードで振動し、所定の音を発生することができる。音はケース４の放音孔４ｄから外部へ放出される。

【００２５】上記構成よりなる圧電音響部品の落下試験を行なった結果を以下に示す。

〔落下試験〕

条件：１００ｇの治具に圧電音響部品を取り付け、１５０ｃｍの高さから木板上にＺ方向（基板を水平）に落下させた時の導電ペースト１５，１６の断線状況を検査した。

ウレタン系導電性接着剤を用いた場合：Ｚ方向１０回ＯＫ

エポキシ系導電性接着剤を用いた場合：Ｚ方向４回で導通（オープン）不良発生

上記のように、振動板１の電極と基板１０の外部電極１３，１４とを接続するための導電ペースト１５，１６として柔弾性を持つウレタン系導電性接着剤を用いた場合には、耐衝撃性において優れた性能を有することがわかる。この時に用いたウレタン系導電性接着剤のヤング率は1×10^{9} Ｎ／m^{2} であり、エポキシ系導電性接着剤のヤング率は5×10^{9} Ｎ／m^{2} であった。

【００２６】次に、上記圧電音響部品の組立方法を図７，図８にしたがって説明する。まず図７に示すように、振動板１を裏返しにしたケース４の内側に、金属板３がケース４の上壁部４ａ側を向くように収納し、その長さ方向両端部、つまり短辺側の２辺を支持部４ｃ上に載置する。この状態で、振動板１の周囲に弾性封止材６をディスペンサなどによって塗布し、硬化させる。これにより、図８の（ａ）のように、内側に振動板１を取り付けたケース４が得られる。次に、図８の（ｂ）のように、振動板１の一端に位置する金属板３の露出部３ａからケース４の開口縁部に形成された溝部４ｅにかけて連続的に導電ペースト１５を塗布する。同様に、振動板１の他端に位置する圧電素子２の表面電極２ａからケース４の開口縁部に形成された溝部４ｅにかけて連続的に導電ペースト１６を塗布する。この場合、導電ペースト１５，１６を立体的なカギ型状に塗布することで、塗布量を増やさずに導通信頼性を高めることができる。上記のように、振動板１は金属板３をケース４の上壁部４ａ側に向けて固定されているので、２つの振動板電極である金属板３の露出部３ａと圧電素子２の表面電極２ａとがケース４の開口部側へ露出することになる。そのため、導電ペースト１５，１６によって簡単に外部へ引き出すことができる。次に、図８の（ｃ）のように、ケース４の溝部４ｅを除く開口縁部に絶縁性の接着剤１９を塗布する。なお、接着剤１９の塗布工程は、導電ペースト１５，１６の塗布より先に行なうこともできる。ただし、この場合には接着剤１９と導電ペースト１５，１６とが重ならないように、接着剤１９を溝部４ｅを除く部分に印刷や転写などで所定のパターンで塗布すればよい。次に、図８の（ｄ）のように導電ペースト１５，１６および接着剤１９が硬化する前に、ケース４の上に基板１０を接着する。この時、接着剤１９が基板１０の表面に密着するとともに、導電ペースト１５，１６がそれぞれ外部電極１３，１４に密着する。この状態で導電ペースト１５，１６および絶縁性接着剤１９を加熱硬化または自然硬化させることで、ケース４と基板１０とが一体化されるとともに、導電ペースト１５により金属板３の露出部３ａと基板１０の外部電極１３とが接続され、導電ペースト１６により圧電素子２の表面電極２ａと基板１０の外部電極１４とが接続される。こうして圧電音響部品を完成する。

【００２７】上記実施形態では、振動板１の全周を弾性封止材６で支持／封止したが、振動板１の短辺側の２辺は接着剤で支持部４ｃに固定してもよい。ただ、弾性封止材６を用いた方が振動板１が自由に振動できるとともに、振動板１の表側と裏側との間の空気漏れをより確実に防止できるので、音圧特性上望ましい。

【００２８】図９は本発明の第２の実施形態である圧電音響部品を示す。この圧電音響部品は、大略、ユニモルフ型の振動板１とケース４０と基板１０とで構成されて

いる。振動板１と基板１０は第１の実施形態で用いられたものと同様である。図９は裏側から見た斜視図であり、ケース４０の内側面全周に段差状の支持部４１が連続的に形成されている。この支持部４１の頂面は同一高さに形成されており、支持部４１上に振動板１の４辺全周が接着剤などの支持材４２によって固定されている。なお、図７のケース４と同一部分には同一符号を付して重複説明を省略する。この実施形態の圧電音響部品は、例えばサウンダやリンガなどのように単一周波数で用いられるものであり、振動板１の全周を支持材４２によって拘束し、振動板１を共振領域で使用することにより、面積屈曲モードで強く励振させることができ、大音量を得ることができる。

【００２９】図１０は振動板の第２の実施形態を示す。この振動板２０は、図６に示す振動板１と同様に、金属板２１の片面に圧電素子２２を接着したユニモルフ型振動板であるが、金属板２１と圧電素子２２は共に同一形状の長方形に形成されている。そして、圧電素子２２の表面には、一端から他端直前まで第１の電極２２ａが形成されており、他端側には金属板２１と端面を介して導通する第２の電極２２ｂが形成されている。この場合も、振動板２０の表面に２つの電極２２ａ，２２ｂが露出するので、図４と同様に金属板２１側をケース４の上壁部４ａに向けて取り付けることにより、導電ペーストで簡単に外部へ引き出すことができる。この場合の導電ペーストも、第１の実施形態と同様に、弾性を持つ導電性接着剤を使用すればよい。

【００３０】図１１，図１２は振動板の第３の実施形態を示す。この振動板３０は、２層の圧電セラミックス層３１，３２を積層したものであり、振動板３０の表裏主面には主面電極３３，３４が形成され、セラミックス層３１，３２の間には内部電極３５が形成されている。２つのセラミックス層３１，３２は、図１２に太線矢印で示すように厚み方向において同一方向に分極されている。表側の主面電極３３と裏側の主面電極３４は、振動板３０の短辺と同幅でかつ長辺よりやや短く形成され、その一端は振動板３０の一方の短辺側端面に形成された端面電極３６に接続されている。そのため、表裏の主面電極３３，３４は相互に接続されている。内部電極３５は主面電極３３，３４とほぼ対称形状に形成され、内部電極３５の一端は上記端面電極３６と離れており、他端は振動板３０の他方の短辺側端面に形成された端面電極３７に接続されている。なお、振動板３０の他方の短辺側端部の上下面には、端面電極３７と導通する細幅な補助電極３８が形成されている。

【００３１】上記振動板３０も図４と同様に、ケースに収納固定され、ケースが基板に接着される。このとき、主面電極３３，３４の一方は、弾性を有する導電ペーストによって基板の一方の外部電極と接続され、補助電極３８は弾性を有する導電ペーストによって基板の他方の外部電極と接続される。そして、外部電極の間に所定の交番電圧を印加することで、振動板３０を長さベンディングモードで屈曲振動させることができる。すなわち、振動板３０の短辺側両端部を支点とし、長手方向の中央部を最大振幅点として屈曲振動させることができる。この実施形態の場合には、金属板を有しない積層構造であり、厚み方向に順に配置された２つの振動領域が相互に逆方向に振動するので、ユニモルフ型振動板に比べて大きな変位量、つまり大きな音圧を得ることができる。

【００３２】図１３は振動板の第４の実施形態を示す。この振動板５０は、３層の圧電セラミックス層５１～５３を積層したものであり、振動板５０の表裏面には主面電極５４，５５が形成され、各セラミックス層５１～５３の間には内部電極５６，５７が形成されている。３つのセラミックス層５１～５３は太線矢印で示すように厚み方向において同一方向に分極されている。主面電極５４，５５は、振動板５０の短辺と同幅でかつ長辺よりやや短く形成され、その一端は振動板５０の一方の短辺側端面に形成された端面電極５８に接続されている。そのため、表裏の主面電極５４，５５は相互に接続されている。内部電極５６，５７の一端は端面電極５８と離れており、他端は振動板５０の他方の短辺側端面に形成された端面電極５９に接続されている。したがって、内部電極５６，５７も相互に接続されている。なお、振動板５０の他方の短辺側端部の上下面には、端面電極５９と導通する細幅な補助電極５９ａが形成されている。この振動板５０も図４と同様に、ケースに収納固定され、ケースは基板に接着される。このとき、主面電極５４，５５の一方は、弾性を有する導電ペーストによって基板の一方の外部電極と接続され、補助電極５９ａは弾性を有する導電ペーストによって基板の他方の外部電極と接続される。

【００３３】例えば、主面電極５４にマイナスの電圧、補助電極５９ａにプラスの電圧を印加すると、図１３の細線矢印で示す方向の電界が生じる。この時、中間層であるセラミックス層５２の両側に位置する内部電極５６，５７は同一電位であるため、電界が生じない。表側のセラミックス層５１は分極方向と電界方向とが同一方向であるため平面方向に縮み、裏側のセラミックス層５２は分極方向と電界方向とが逆方向であるため平面方向に伸びる。そして、中間層５２は伸び縮みしない。そのため、振動板５０は下方へ凸となるように屈曲する。端面電極５８，５９間に交番電圧を印加すれば、振動板５０は周期的に屈曲振動を生じ、これによって大きな音圧の音を発生することができる。

【００３４】なお、金属板および圧電素子は長方形に限らず、正方形であってもよい。また、上記実施形態では、金属板の片面に圧電素子を貼り付けたユニモルフ型振動板、圧電素子を積層した積層型振動板とについて説明したが、両端部の片面側に第１，第２の振動板電極が

露出し、長さベンディングモードまたは面積屈曲モードで振動する四角形の圧電振動板であれば、いかなる圧電振動板を用いてもよい。本発明の圧電音響部品としては、圧電ブザー、圧電受話器、圧電スピーカ、圧電サウンダ、リンガーなどがある。

【００３５】

【発明の効果】以上の説明で明らかなように、請求項１に記載の発明によれば、四角形状の振動板を用いたので、グリーンシートの打ち抜きから親基板カットに至る工程における金型、治具、圧電体品種を少なくでき、かつ材料効率もよいので、生産効率が向上し、製造コストを低減できる。また、四角形状の振動板の対向する２辺をケースの支持部に支持し、振動板の他の２辺とケースとの隙間を封止し、長さベンディングモードで振動させるようにしたので、最大変位点が振動板の長さ方向の中心線に沿って存在し、変位体積を大きくできる。そのため、円板状の振動板に比べて音響変換効率を高めることができる。そして、四角形状の振動板はその２辺が支持されるが、その間の部分は自由に変位できるので、円板状の振動板に比べて低い周波数を得ることができる。逆に、同じ周波数を得るのであれば、寸法を小型化できる。さらに、振動板電極と基板の外部電極とを接続する導電性接着剤が弾性を持つので、本圧電音響部品を搭載した機器を誤って落下させたりして大きな衝撃荷重が加わっても、導電性接着剤が衝撃を吸収し、振動板電極と外部電極との間が断線する恐れを解消できる。また、導電性接着剤の硬化後のヤング率が低いので、振動板の振動を妨げず、音圧特性が向上するという効果を有する。

【００３６】また、請求項２に記載の発明では、四角形状振動板の４辺をケースの支持部に支持し、面積屈曲モードで振動させるようにしたので、共振領域で使用されるサウンダやリンガなどに適した圧電音響部品を実現できる。この場合も、請求項１と同様に、振動板電極と基板の外部電極とを弾性を有する導電性接着剤で接続したので、耐衝撃性能が向上し、小型で音圧特性に優れた圧電音響部品を実現できる。

【００３７】また、請求項６，７のように、振動板がケースの開口部から２つの振動板電極が露出するように取り付けられるので、振動板電極と基板の外部電極とを接続する導電性接着剤の塗布作業が容易になるとともに、ケースと基板とを接着すると同時に振動板電極と外部電極との電気的接続も行なわれるので、製造工程を簡素化でき、工程の処理時間を短縮できる。したがって、請求項１，２の圧電音響部品を安価に製造することができる。

【図面の簡単な説明】

【図１】円形振動板と四角形振動板との変位分布の比較図である。

【図２】円形振動板と四角形振動板の寸法と共振周波数との関係を示す図である。

【図３】本発明にかかる圧電音響部品の第１の実施形態の斜視図である。

【図４】図３のＸ－Ｘ線断面図である。

【図５】図３のＹ－Ｙ線断面図である。

【図６】振動板の斜視図である。

【図７】ケースと振動板とを裏面側から見た分解斜視図である。

【図８】振動板を組み込んだケースと基板との組立方法を示す工程図である。

【図９】本発明にかかる圧電音響部品の第２の実施形態の斜視図である。

【図１０】振動板の第２の実施形態の断面図である。

【図１１】振動板の第３の実施形態の斜視図である。

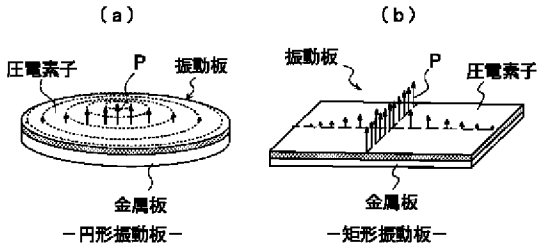
【図１２】図１１に示す振動板の断面図である。

【図１３】振動板の第４の実施形態の断面図である。

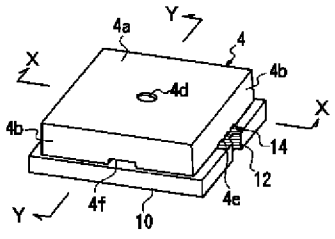
【符号の説明】

１	振動板
２	圧電素子
２ａ	表面電極
３	金属板
４	ケース
４ａ	上壁部
４ｂ	側壁部
４ｃ	支持部
６	弾性封止材
１０	基板
１３，１４	外部電極
１５，１６	導電ペースト（弾性を持つ導電性接着剤）
１９	絶縁性接着剤

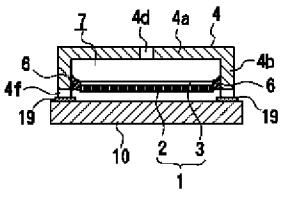
【図１】



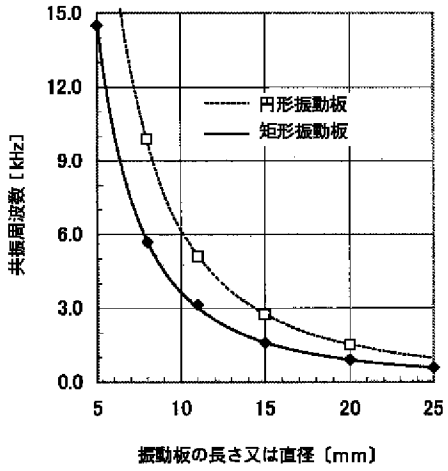
【図３】



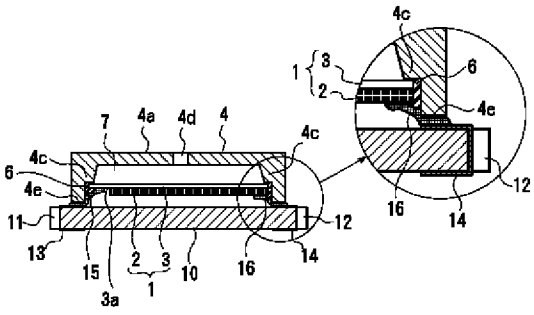
【図５】



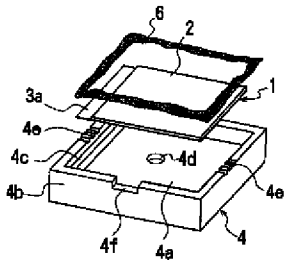
【図２】



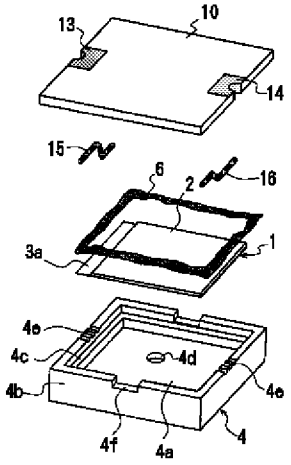
【図４】



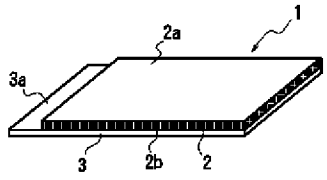
【図７】



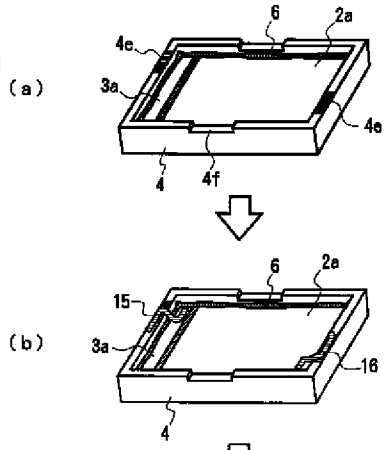
【図９】



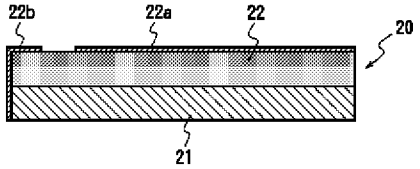
【図６】



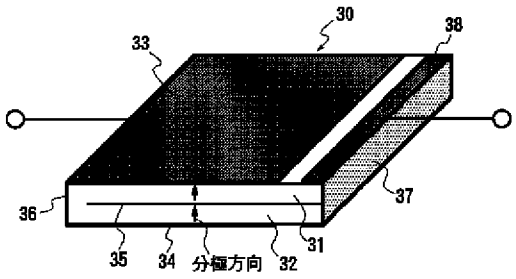
【図８】



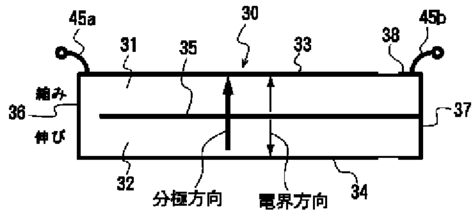
【図１０】



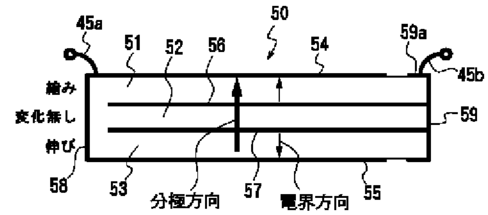
【図１１】



【図１２】


45a
31
35
30
33
38
45b
縮み
36
伸び
37
32
分極方向
電界方向
34

【図１３】


45a
51
52
56
50
54
59a
45b
縮み
変化無し
伸び
59
58
53
分極方向
57
電界方向
55